The JEA

Atmospheric Fluidized Bed Combustor Clean Coal Project

Repowering Northside Units 1 and 2

"Our nation must have a … broad, comprehensive energy strategy, that calls upon the best of the nation's entrepreneurs to help us develop the technologies necessary to make wise choices in the market-place, as well as calls upon our nation's innovative technologies to help us find new sources of energy."

George W. Bush, Remarks to Department of Energy Employees, June 28, 2001

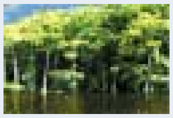
JEA is the eighth largest municipal utility in the United States providing electric, water, and wastewater service to more than 600,000 customers in Northeast Florida. JEA will demonstrate an extraordinarily clean, new way of producing electricity when two 300-megawatt, circulating fluidized-bed (CFB) combustors go online for the first time at the Northside Generating Station in Jacksonville, Florida, in 2002. CFB technology is more efficient, cleaner, and less costly than competing conventional power-generation systems. The two circulating fluidized bed combustors replace obsolete boilers at the Northside Generating Station that used expensive natural gas and fuel oil.

Repowering Unit 2 is made possible through an approximately $74 million cost share from the Department of Energy's (DOE) Clean Coal Technology Demonstration Program, responsible for developing, testing, and demonstrating innovative energy-producing technologies. Unit 1 is also being converted to a CFB and is funded entirely by JEA.

Northside Unit 2 will provide operating experience and produce economic, environmental, and technical performance information for future CFB units. Unit 2 will burn inexpensive high-sulfur coal or petroleum coke, both of which are abundant, to produce nearly 300 megawatts of power on an annual basis, enough to light over 250,000 average households, for as long as the plant is operational.

Together, these two units will yield almost 600 megawatts of power, and will be the largest CFB combustors to operate on a commercial scale anywhere in the world. This technology removes sulfur dioxide (SO_2), nitrogen oxides (NO_X), and particulate matter. Sulfur and nitrogen oxides can form acid rain, and excessive NO_X emissions lead to ground-level ozone smog. Also, certain particulate matter causes respiratory problems.

Jacksonville



A half century after Ponce de Leon claimed Florida for Spain, Frenchman Jean Ribault sailed into the St. Johns River to establish Fort Caroline for French Huguenots. Within several years, Spanish forces from the military garrison at St. Augustine would destroy this small settlement.

In 1821 Spain ceded Florida to the United States and one year later, Isaiah D. Hart surveyed the village and named it Jacksonville for General Andrew Jackson, the territory's first military governor.

Today, located at the crossroads of two transcontinental highways, Jacksonville is one of the nation's largest cities in land area (841 square miles), a major port, site of Navy bases, and home of the NFL Jacksonville Jaguars, a Mayo Clinic medical center, the Jacksonville Zoological Gardens, and boasts beautiful beaches and numerous waterways for over 700,000 residents.

The Clean Coal Technology Demonstration Program

The Clean Coal Technology Demonstration Program (CCT Program), a model of government and industry cooperation, responds to the DOE mission to foster a secure and reliable energy system that is environmentally and economically sustainable. The CCT Program represents an investment of over $5.2 billion in advanced coal-based technology, with industry and state governments providing an unprecedented sixty-six percent of the funding. Comprising thirty-eight projects, the CCT Program has yielded clean coal technologies that are capable of meeting existing and future environmental regulations and competing in a deregulated electric power marketplace.

The CCT Program has extended the technical, economic, and environmental performance envelope of a broad portfolio of advanced coal technologies. As of August 2001, a total of twenty-nine CCT demonstration projects have completed operations, three are in operation, two are in construction, and four are in design.

Technical results of the demonstration projects are available online in the Clean Coal Compendium at URL: **www.netl.doe.gov**
Select *Technologies*, then *Clean Coal Technology Compendium*

Northside Generating Station's Units 1 and 2: The turbine building is on the right, the circulating fluidized bed units are in the center, the two 48-foot diameter polishing scrubbers are left of center, and the 500 foot high stack is on the left. The solid fuel storage domes are in the background of the picture.

Aerial view of JEA Northside Generating Station's Units 1 and 2 showing the CFB's under construction. The 500-foot high gas stack is in the foreground of the picture with the two flues visible on the top. Unit 2 is to the left and Unit 1 is to the right. Directly behind the stack are the baghouses that serve to remove particulate matter. Moving back, the silver towers (Unit 1's is incomplete) are the polishing scrubbers for removing sulfur from the flue gas. The framework holding the circulating fluidized bed boilers is the next large structure moving backwards. The long building at the top of the picture is the turbine building.

How CFB's Work

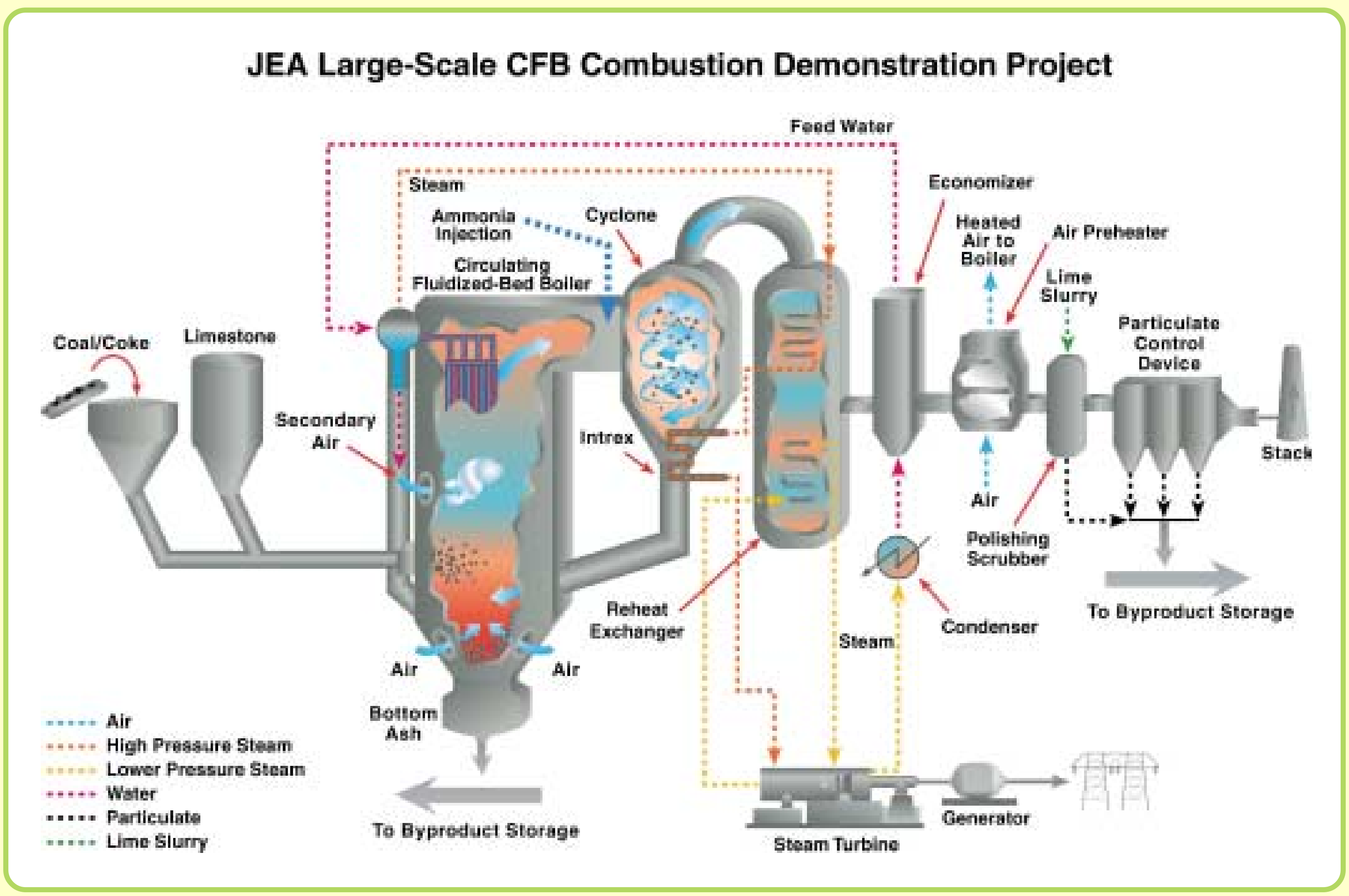
A Circulating Fluidized Bed is a large furnace (commonly called a combustor) that burns fuel to produce heat and boils water to create steam. The steam drives a turbine connected to an electric generator.

The solid fuel is crushed to about 1/4 of an inch in diameter and mixed with limestone crushed to the size of sand. The limestone absorbs up to 90 percent of the sulfur in the fuel as it burns in the furnace. The fuel/limestone mixture is blown into the base of the combustor with heated air. As the fuel/limestone mix rises, it ignites and begins a controlled "slow-burn." This "slow-burn" process maintains temperatures below 1,600°F across a large area while lower temperatures help minimize pollution. Temperatures above 1,600°F are responsible for forming large amounts of NO_X. As the fuel particles burn, they become lighter and, with the help of additional air that constantly turns the particles over in a fluid-like motion, are carried higher in the combustor.

At the top of the combustor ammonia is injected into the gas stream to further reduce nitrogen oxides produced in the furnace. The hot ash and limestone are separated in a cyclone and recycled back into the combustor through an INTREX™ exchanger before being recycled back into the bottom of the combustor. The INTREX™ has superheated steam tubes over which the hot ash flows. The ash tranfers heat to the steam in the superheater tubes and acts as an excellent means of controlling the steam temperature as it goes to the turbine. Steam is also generated when water is pumped through the tubes that form the walls of the combustor and cyclone. Excess solid material is removed from the bottom of the combustor and sent to by-product storage.

As the hot gases leave the top of the cyclone, they enter additional reheater/superheater tubes that also generate steam for the turbines. The still hot flue gas is then used to heat the main combustion air before it enters the bottom of the furnace.

After the reheater/superheater phase, the flue gas enters an air quality control system where it travels downward through a polishing scrubber that applies a lime slurry to absorb SO_2. Following the scrubber, the flue gas passes through a bag house containing fabric filters to further clean the stack gas before it is sent up the stack. The collected particulates are sent to by-product storage.



Environmental Control Technology

- Design Emission Rates: Nitrogen oxides – 0.09 lbs per million Btu, sulfur dioxide – 0.15 lbs per million Btu, and particulate matter – 0.011 lbs per million Btu.
- Scrubbers maximize sulfur removal.
- Low NO_X combustors with ammonia injection minimize NO_X emissions from stack gases.
- Fabric filters limit particulate emissions.
- Fugitive emissions are controlled by minimizing the number of bulk material transfer points; enclosing conveyors and drop points; enclosing the fuel storage area; using wet suppression to control particulate emissions; installing collection devices, such as baghouses.

> **"In summary, the Clean Coal Technology program... serves as an example to other cost-share programs in demonstrating how the government and the private sector can work effectively together to develop and demonstrate new technologies."**

Jim Wells, Director, Natural Resources and Environment, United States General Accounting Office, Report: *Lessons Learned in the Clean Coal Technology Program*
Testimony before the Subcommittee on Energy, Committee on Science, House of Representatives, June 12, 2001

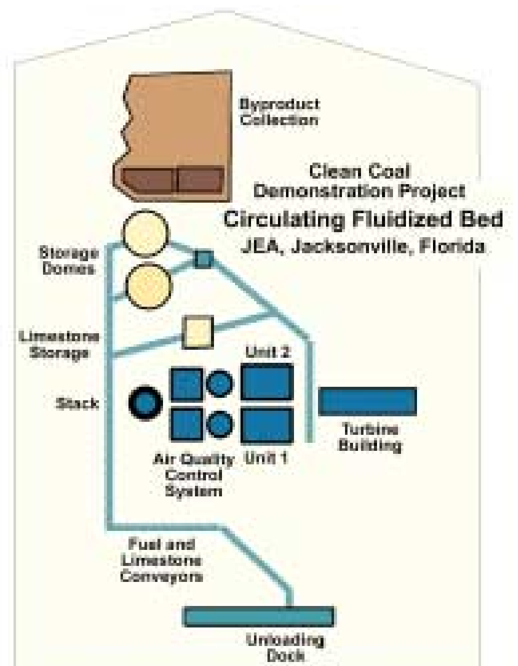
Timucuan Ecological and Historic Preserve

Designated: February 16, 1988

The 46,000 acre Timucuan Ecological and Historic Preserve was established to protect one of the last unspoiled coastal wetlands on the Atlantic Coast and to preserve historic and prehistoric sites within the area. The estuarine ecosystem includes salt marsh, coastal dunes, hardwood hammock, as well as salt, fresh, and brackish waters. All of these are rich in native vegetation and animal life.

The Preserve was inhabited by the native Timucuan people for over four thousand years before the arrival of the first Europeans. The Timucuan Preserve has within its boundaries federal, state, and city park lands, and over 300 private landowners.

JEA Northside Generating Station as seen from the St. Johns River. In the foreground of the picture is the unloading dock with the continuous solid fuel unloader (painted light blue) and a fuel oil tanker moored at the dock. A covered conveyor runs from the dock across the island and waterway to Units 1 and 2. The 500-foot tall stack for Units 1 and 2 is seen in the center of the picture. Units 1 and 2 are just to its right, and the long, low building is the turbine building for both units. The solid fuel storage domes are behind Units 1 and 2.



Benefits

Overall, CFB's have good potential to be used commercially because they offer:

Fuel-flexibility

An attractive feature of the CFB is its ability to burn a variety of solid fuels, including low-grade coals and waste by-products that are less expensive than natural gas and oil, while maintaining very low emissions of SO_2, NO_X and particulate matter.

Impressive environmental performance

The CFB's in Jacksonville will produce fewer emissions than the Northside Station is licensed for. In fact, these two CFB's will be operated to reduce emissions by 10 percent over previous operations. The CFB design can reduce SO_2 emissions by 98 percent, NO_X levels by 60 percent and particulate matter by well over 50 percent.

Versatility

CFB's can be built as new facilities or they can re-power existing plants and serve well as industrial or utility power plants. In a repowering application, solid fuel- and ash-handling equipment and existing steam turbines are retained, extending plant life and saving capital costs. In addition, CFB's can operate at 100 percent baseload capacity continuously and can be easily turned down to forty percent of full capacity if needed.

A salable by-product

The solid fly ash-limestone mixture that is expelled from the combustor can be easily disposed of or sold as a by-product. Water will be added to the mixture that will then be pumped to a storage pond about a half mile from the power plant where it will solidify much like cement. Afterward it will be broken and sold in granular form to be used as road fill. This option reduces the need for placing the by-products in a landfill.

The by-product storage and handling area in the foreground with the solid fuel storage domes in the right hand side of the picture along with Units 1 and 2 in the background.

All photos courtesy of Chris Newton

Project History

Construction on Unit 2 began in August 1999. New equipment in Unit 2 includes the circulating fluidized bed, heat exchangers and steam generators, air quality equipment (polishing scrubber and baghouse), and an approximately 500-foot high stack equipped with two flues. An 805-foot long fuel receiving dock equipped with a continuous ship unloader and some 12,000 feet of new belt conveyors transport the solid material from the unloader to the storage facilities. Solid fuel is stored in two 400-foot diameter by 140-foot high geodesic domes prior to being crushed and conveyed to the two CFB's. Each geodesic dome holds about 66,000 tons of solid fuel. New ash collection and by-product storage facilities were added as part of the Northside Station's repowering.

In addition to the new CFB's existing auxiliaries, the older steam turbines and electric generators have been upgraded. A new distributed control system and electric switchyard will manage the electricity flow from the plant to the power grid.

The first solid-fuel firing of Unit 2 is set for November 2001. The unit is to be completed in February 2002, with commercial operations slated to begin three months later. On September 15, 2001, JEA's existing Unit 1 was shut down and the newly constructed Unit 1 - an identical twin to the DOE cost-shared Unit 2 - will be tied to the turbine and generator of the original Unit 1.

The solid fuel storage domes, conveyors, and crushing building.

JEA Units 1 and 2 are located near the Atlantic Ocean and associated wetlands. Solid fuel storage at the site is designed to protect the environment. These domes provide a maximum economy of shape with a minimum of wasted space and materials. They are 400 feet in diameter and 140-feet high; each stores about 66,000 tons of solid fuel. Solid fuel is conveyed from the loading dock to the domes with a 12,000-foot long conveyor system. Prior to use, solid fuel will be conveyed from the domes to the crusher where it will be sized for injection into the fluidized beds and conveyed to silos located next to the CFB's. The domes prevent weathering of the fuel, minimize dust pollution, and prevent rainwater runoff from contaminating the surrounding property.

The Domes were designed and manufactured by Geometrica, Houston, Texas, *www.geometrica.com*

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